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ABSTRACT

It is proposed that the only technology that has consistently been effective over traditional education approaches is the personalized system of instruction (PSI). An overview is given of the purpose, origin, development, and use of the system. The five critical components are outlined: use of student assistants, emphasis on the written word in student-teacher communication, use of lectures and discussions as a means of inspiration and motivation rather than a source of critical information, the unit perfection requirement for advancement, and working at the student's own pace. Another essential feature is a set of detailed performance objectives. Research on the effectiveness of the method is reviewed. Problems in implementation are also addressed, and some recommendations are made, including future research needs. It is concluded that college instructors could improve their teaching by implementing PSI as a major teaching method, and that PSI provides colleges with one technology to bring about changes for more effective instruction. A list of references and a PSI flow chart are included. (MSE)

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AN INSTRUCTIONAL ALTERNATIVE FOR COLLEGE INSTRUCTORS: PSI

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Searching for an Instructional Alternative

Over the past decade, colleges and universities have been subjected to a great deal of criticism. Local communities are demanding that colleges be accountable for the instruction provided. Students are taking more of a consumer's role when involved with college education. They are demanding to be taught skills in an efficient, effective and humanizing manner. Keller (1977) plainly stated that present higher educational systems do not meet the need of modern life.

Many problems with higher education can be directly tied to the instructional strategies employed. The lecture technique has typically been the dominate teaching tactic used since institutions of higher education first emerged (Ruskin, 1974). Teaching at the college level has been more of an art than a science. Seldom, if ever, are the teaching tactics of the faculty subjected to intense scrutiny. Promotion at the college level is hardly ever tied to an evaluation of one's skill as a teacher (Johnston, 1975). Typically when one is evaluated on teaching ability it comes down to how well a person entertains during the lecture. Lectures have not proven themselves to be an effective means of teaching because they do not produce consistent changes in student performance (Johnston, 1975). If not lectures as the primary means of teaching, then what?

A new alternative has been the result of what Ruskin (1974) has called the fifth revolution in education - the adoption and testing of basic behavioral principles to higher education. McGaw (1975) has enumerated these basic behavioral principles as the following:

A) specification of learning objectives;

B) organization of the learning material into small achievable units of instruction;

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C) active student involvement;

D) frequent assessment;

E) immediate feedback;

F) learning rate determined by the learner;

G) criterion mastery of course materials, and

H) management of contingencies to ensure a positive learning environment.

The application of these behavioral principles has helped improve the quality of instruction in institutions of higher education (Alba & Pennypacker, 1972). This application also allows a system to meet the charge specified by Shores, Burney and Wiegerink (1976) to evaluate instructional tactics on the basis of student performance. These behavioral principles became the foundation for a new wave of instructional technology aimed at improving college education. This new technology included such innovations as audiotutorial instruction, computer assisted instruction, individually prescribed instruction, contingency management, precision teaching and personalized system of instruction. In the 1970s a fair amount of research was conducted to evidence the value of these new approaches. However, the only technology that has consistently proven its effectiveness over traditional educational approaches is personalized system of instruction (Kulik & Jaksa, 1977).

Personalized system of instruction (PSI) was first introduced by Keller (1968) in his landmark article, "Goodbye Teacher...." Keller's intent was to apply behavioral principles to an introductory psychology course. Since that time PSI has been subjected to an intense review by many researchers, students, administrators and teachers. Perhaps, PSI's strength is that is has proven itself on the basis of empirical data (Semb & McKnight, 1977). According to

Ofish (1973) there has probably been no development in higher education which has had as significant an implication for potentially reforming higher education as PSI. PSI provides a viable alternative to students and teachers. It is a solution to many of the problems of contemporary mass education (Calhoun, 1973). A review of PSI's critical components and the research conducted on PSI is imperative for all those concerned with quality instruction in higher education.

Personalized System of Instruction: An Overview

PSI was born from reinforcement theory and the work of applied behavior analysts. The raison d'etre of PSI is to provide individualized education to large groups of students and to ensure their mastery of the content. According to Keller (1977), it allows the student to move through any material at his own pace, but with accountability at every step. PSI ensures that each student will receive equal credit for work completed. Due to its personalized features PSI allows students to receive a good deal of encouragement and guidance as they progress through the course.

PSI has been successfully employed in a variety of disciplines. It has been used to teach psychology (Farmer, Lachter, Blaustein & Cole, 1972; Born & Herbert, 1971), history (Beyer, 1976), sociology (Clark, 1974), math (Roberts, 1975; Hasset, 1978), biology (Glick, 1973), medicine (Schimpfhauser & Richardson, 1977), statistics (Brook, 1977), physics (Hedges, 1975), chemistry, engineering, English and library science (Stice, 1975). PSI has been successfully introduced into non-college settings and has been used to teach high school history (Bailey, 1976), fifth and sixth grade social studies and science (McLaughlin, 1977) and even second grade math and reading (Werner & Bono, 1977). PSI techniques appear not to be limited to any one field and provide a valuable teaching technique to any field and to many educational environments.

As it was first described (Keller, 1968) PSI has five critical components which separate if from traditional instruction. These are:

1) Use of student assistants (often called proctors, managers, tutors) whose role it is to assist students and measure their performance as they move through the course;
2) Emphasis upon the written word in teacher-student communication;
3) Use of lectures and discussions primarily as a means of inspiration and motivation rather than a source of critical information;
4) Unit perfection requirement for advancement, which lets the student advance to new material only after demonstrating mastery of previous units;
5) The go-at-your-own-pace feature which allows students to move throught the material at a speed commensurate with their abilities and other demands on their time.

In addition to these components students in a PSI course receive a detailed set of learning objectives that clarifies what the student will need to master. All course work is broken into study units arranged in a manner that will allow rapid achievement. Students in a PSI course also are assessed frequently and receive immediate feedback. This frequent assessment allows students to know where they are in regard to the learning objectives at all times throughout the course. Students can retake tests without penalty, as often as necessary to demonstrate competency. The major rationale behind PSI is the belief that individual communication and instruction are more successful and effective than lectures to large groups (Johnson, Chase & Maass, 1977).

The student entering a PSI course will first receive detailed instructions about the format for the course and expectations for students, assistants, and the instructor. The student then receives his first study unit. The unit

includes learning objectives, study questions and a detailed setof readings from texts and other sources. Students can pursue their study in the classroom or in other places. Students are encouraged to pursue this work in a method suited to them. Small group work is encouraged. Students only need to return to the classroom to take a mastery test when they feel they understand the material.

When a student is ready to be tested he will seek out an assistant who will hand him a criterion referenced test consisting of short answers (fill-ins and multiple choice) and one or two short essay questions. Upon completing the test the student returns it to the assistant who gives the student immediate feedback. The assistant may ask the student to defend any wrong or questionable answers. This interaction usually yields a discussion about the unit material. If the student reaches criteria, he is congratulated, his progress recorded and he then reveives his study packet for the next unit. If he fails to reach criteria the assistant will specify where he should concentrate his study. When the student feels ready to demonstrate mastery he is given a different form of the unit test. This cycle is completed until all units are completed. A simple flow chart for this sequence is presented in Figure 1.

Insert Figure 1 About Here

Lectures in a PSI course are infrequent and students earn access to these lectures after they have demonstrated mastery of the criteria prerequisite to appreciating the lecture (Keller, 1968). Attendence at these lectures is never required and students are not tested on the content of lectures. Lectures serve a much different role in PSI than in traditional education.

If the instructor seems a bit off center stage in a PSI class, his role is anything but diminished. In PSI the instructor is an educational engineer; a manager of student learning (Keller, 1971). The instructor is a goal setter, test constructor, prescriber, motivator, resource person, administrator, tutor and in general, a facilitator of learning. The instructor trains and supervises the assistants, delivers the infrequent lectures and checks all the students' written work. The instructor handles inevitable problems and redesigns the course materials as needed. Evaluation and research activities concerning the course are also generated by the instructor. In PSI the role of the instructor is critical.

The assistants make the course personalized by providing the one-to-one contact often missing in traditionally taught courses. The assistants are usually undergraduate students who have successfully completed the course earlier and they usually receive academic credit for their work. In well run PSI courses assistants learn the subject to a more articulate degree (Cook, 1974). The assistant is the primary source of external reinforcement for the student (Kozma, Belle & Williams, 1978). The typical student to assistant ratio is ten to one. The purposes of the many tests are to provide students with a high rate of corrective feedback and to help students distribute study behavior over an entire course (Ryan, 1974). In PSI the normal curve is rejected (Ruskin & Ruskin, 1977). Each student has an equal chance to be successful. Typically the grades in a PSI course are skewed with most of the students receiving an A. Students who reach criteria on all units receive an A. Other grades can be given depending on the number of units completed. In some cases instructors give students only two grading options, A or F or A or incomplete. (A look at research on various grading options will be presented later.) Examining and teaching are inseparable parts of the same process (Keller, 1966). Students taking a PSI course, however, earn something

better than a mere letter grade. They have a list of specific educational accomplishments.

The amount of material covered in a PSI course is equal to or greater than that covered in a traditional course. The work is usually divided into units so the student can easily study and pass one unit per week.

Many students report that they work harder in a PSI course. However they also rate the course higher (Croft, Johnson, Zlottow, & Berger, 1975) than traditional courses. In general students who complete PSI courses are well pleased with its unique features.

PSI advocates have urged that this method be subjected to the rigors of empirical research. If PSI really is more effective, proponents would need to provide more than testimonials. The strength of this inovation, or any other should rest on data. A review of the significant research data on PSI follows in the next chapter.

Is PSI Effective? A Look at Some Research

As mentioned earlier, the strength of PSI has been that those responsible for its development have relied on the scientific analysis to demonstrate its value. Because of these research efforts PSI advocates can go beyond their testimonials and evidence their claims with data. Basically there has been two distinct research efforts in regard to PSI - outcome analysis and component analysis. The focus of outcome analysis has primarily been to assess PSI courses with lecture courses in terms of end of course performance by students, student attitudes, retention and generalization. Component analysis has been concerned with the verification of the value of specific components of PSI. This chapter reviews some of the more significant PSI studies conducted over the past twelve years.

End of Course Performance

Comparisons of various teaching methods at the college level have typically not proven to be conclusive (Kulik, Kulik, & Smith, 1976). However, PSI has been compared with other methods and has demonstrated its effectiveness. Comparison of PSI has usually been with traditional lecture courses and the major evaluation tool has been an end of course examination. Several studies comparing a PSI course with a lecture course (Keller, 1968, Lloyd & Knutzen, 1969, McMichael & Corey, 1969; Sheppard & MacDermot, 1970; Alba & Pennypacker, 1972; Born, Gledhill & Davis, 1972; Calhoun, 1973; Hursh, Sheldon, Minkin, Sherman & Wolf, 1973; Clark, 1974; Caldeway, Santowski, O'Brien, & Lagowski, 1974; Cole, Martin & Vincent, 1975; Croft, Johnson, Zlotlow & Berger, 1975; Hedges, 1975; Stice, 1975) have indicated that students in PSI courses consistently do better on final examinations than their peers receiving instruction via the traditional lecture method. Many of these authors have tried to bias the control groups (lecture instruction) by presenting questions they were familiar with and urging the PSI groups not to specially prepare for the final because it would not be counted toward their grade. Still PSI students outperformed lecture students. Kulik, Kulik and Smith, (1976) located 39 studies comparing PSI and lecture students using a final examination. They found that in 38 of these 39 studies final examination performance was better for the PSI groups.

Mostly what has been published are the results of final examinations. What is lacking in this research is the reports of gain scores by students. Seldom if ever, were students given pretests before PSI instruction was initiated. An effort to demonstrate the gains made by students in the process of instruction has been the work of Miller and Weaver (1972). They

have developed a procedure known as a multiple baseline achievement test. Using this procedure to assess outcomes of PSI would allow gain scores to be determined for individual students or groups.

This comparison research is only initially impressive. As one looks at these studies in detail many questions are raised. Generally these studies have been weak in regard to controlling variables. Cook (1974) criticized many of these studies because typically students were not randomly assigned to control or experimental groups. In some cases the PSI course compared was held at different times, semesters or even colleges. The variables that may have been responsible for improved performance were simply not controlled.

Another problem with this study is the direct comparison of student grades. In many lecture classes grades are based on a norm-referenced system. In PSI courses grades are based on a criterion-referenced system. These grades can not be easily compared. Researchers would have better served the understanding of PSI by controlling the grading system or by thoroughly explaining the grading system employed.

Another problem with these comparisons is that each author has added or deleted aspects of PSI described by Keller (1968). Comparison of one PSI course to others is not easily made (Powers, 1972). Wood and Wylie (1975) also criticized the PSI comparison research by saying that unless the withdrawal population is also considered one can't really compare PSI with lecture courses. Even though these studies have contained methodological flaws they served as a springboard for future research efforts. On the basis of these reports a more thorough analysis of PSI seemed warranted.

Student Attitude

Educators need to develop instructional technologies that will not only produce effective and efficient skill acquisition but also result in student satisfaction (Whitehurst, 1972). A number of researchers (Sheppard & MacDermot, 1970; Clark, 1974, McMichael & Corey, 1969; McGaw, 1975;) all report that students in PSI courses rate it highly as measured by typical student course evaluation forms. It appears that students are well satisfied with the PSI format.

Hursh, Sheldon, Minkin, Minkin, Sherman and Wolf (1973) reported that students rated a PSI course higher than lecture students did when all students used the same materials. Students in this study reported the PSI course more interesting even though it required more work. Croft, Johnson, Zlotlow, and Berger (1975) reported a study in which the same instructor taught both a traditional course and a PSI course. Students in both classes evaluated the course and the PSI students rated the instructor higher and indicated they were more satisfied with the course.

Just citing the results of student attitude research is not very impressive. Similar to the end of course research these studies have a fair amount of flaws. Researchers have used different evaluation forms and evaluation methods. Hassett (1973) demonstrated that using different evaluation forms may yield different results and urged educators nto to rely on this type of data alone when evaluating the effects of PSI.

Retention

A major concern of educators is how much information students retain after a course is complete. Ruskin (1974) and Ryan (1974) both suggested that PSI researchers need to concentrate their efforts on demonstrating the long-term effects of PSI instruction in regard to the materials presented.

In one study, Coldway, Santowski, O'Brien and Lagowski (1974) compared different groups of students and how a PSI course effected long-term performance. The results of this study indicated that PSI students retained more information than lecture students. Cole, Martin and Vincent (1975) conducted a follow-up exam for different groups of students and found that PSI students retained more information than lecture students.

Kulik, Kulik, and Smith (1976) reviewed nine studies that focused on retention. In each case PSI students performed significantly better on follow-up exams. Kulik and Jaksa (1977) stated that in the present retention studies the average retention score for PSI students was 24 percent higher than the average retention score for students in conventional classes.

Generalization

How well will PSI students perform in other courses, especially courses taught in traditional manners? This question has been addressed by several researchers. Cook (1974) in reviewing several studies of PSI noted that PSI courses improve student study habits and performance in other conventionally taught courses. This was especially true in subsequent courses in related fields.

Hedges (1975) conducted a longitudinal study to investigate the long-term effects of PSI instruction. Hedges compared two similar groups that both took a beginning physics course. One group received PSI instruction and the other group was taught physics by the lecture method. He compared the students in subsequent chemistry and biology courses taught in a traditional manner. The PSI students not only did better in the physics course but also did better in subsequent courses. Hedges also compared GPA's of the students in their junior year and found that the PSI students had higher GPA's. He concluded that PSI

students are not at a disadvantage because of receiving PSI instruction and PSI students may have developed habits that resulted in better performance.

It appears that PSI students learn skills that transfer to new situations. PSI can be helpful to teachers not only in communicating information but also in achieving more ambitious instructional goals such as development of proper study habits and the ability to do independent study.

Assistants (Proctors)

Ruskin (1974) pointed out that it is the assistant component that truly makes PSI courses personalized. Cook (1974) said that the use of assistants who interact with students is an extremely important component in PSI. However, as one looks at the present data there seems to be conflicting evidence.

Farmer, Lachter, Blaustein, and Cole (1972) varied the amount of proctoring students received from 0 percent of the time, to 25 percent of the time, to 75 percent of the time to 100 percent of the time. They found that the proctored students were superior to non-proctored students in regard to examination performance. However, the amount of proctoring that students received did not effect final examination performance. The major effect of increased proctoring was that students accelerated their rate of progress through the course. These authors claim that the use of assistants extends the effectiveness of PSI and suggest that the use of intermittent proctoring helps students move through the course at greater degrees of independence.

Hursh, Sheldon, Minkin, Minkin, Sherman, and Wolf (1973) investigated the effects of different proctoring behavior on student performance. They focused their attention on the discussions between assistants and students regarding quiz questions. Although students reported that they preferred to discuss their answers with an assistant, these discussion only slightly added to higher scores on first attempts at taking the quiz.

Some researchers investigated the use of proctors in various settings. Faucett and Miller (1975) used proctors to supervise field work of undergraduate students. This was a similar application of the work of Shores, Stowitschek, and Kerr (1976) who used field supervisors to facilitate the supervision and progress of graduate students in the Field-Based Teacher Training Program at George Peabody College for Teachers of Vanderbilt University. In other work, Stowitschek (1976) found it feasible to incorporate proctors into a teacher training package.

Assistants in Johnston and Pennypacker's (1971) PSI course had a unique role. They were responsible for conducting and grading student performance sessions. These performance sessions called for the student to orally present the material in the study unit. Johnston and Pennypacker investigated the use of a pool of assistants in this system rather than assigning students specific assistants. They found this approach to be effective in terms of student performance and as a successful way of managing meager financial and manpower resources.

Perhaps the biggest single job of the assistant is grading unit tests. Blackburn, Semb, and Hopkins (1975) compared a traditional PSI class with a PSI class that involved student self-grading. On final exam performance proctor and self-graded classes performed equally well. This seems to be in conflict with the results found by Farmer, et al. (1972). Blackburn et al. suggest that their finding indicate that although proctors may be useful as administrative assistants their number could be drastically reduced and thus a PSI course made much less taxing on educational systems.

In analyzing all the research conducted on assistants the evidence is in contradiction. Kulik, Kulik and Smith (1976) in their review of these

studies state that there is ro conclusive evidence that assistants make a significant contribution to PSI's educational effectiveness.

Self-Pacing

Keller's (1968) intent for PSI was to establish a course where students could progress at their own rate. However, this has led to a number of administrative problems as well as student procrastination problems. Lloyd and Knutzen (1969) found that the longer the students procrastinated the harder it was for them to start the course. They urged PSI instructors to incorporate contingencies that would encourage students to start their work early in the semester.

Stice (1975) investigated student procrastination in several PSI courses and found:

A) Instructor imposed deadlines had little effect on procrastination,

B) Changing the student to assistant ratio had little effect on procrastination,

C) Freshmen and Seniors exhibited more procrastination than other students, and

D) Students who had a PSI course previously exhibited less procrastination.

Lu (1976) conducted two similar experiments in an attempt to curb procrastination. He used a point system and praise to reward students for completing work on time. He found that procrastination behavior can be modified by appropriate contingency managment.

In a study to determine retention differences in a self-paced PSI course and an instructor-paced PSI course, Surber, Morris and Bijou (1976) found no differences between the two groups in pre-post and follow-up examinations. These authors suggest that self-pacing may not be critical and that many PSI courses could lend themselves to instructor pacing.

Reiser and Sullivan (1978) investigated the difference between an instructor-paced PSI course and a self-paced PSI course in regard to the number of students who withdrew. They found that less students withdrew if the course was instructor-paced. These researchers have suggested that student self-pacing be negotiated with each individual student and that the instructor provide reinforcement for students achieving at a certain pace. They also suggest that PSI instructors establish strict criteria for achievement rates at the beginning of the course.

Even though self-pacing was outlined by Keller (1968) as a critical component of PSI, research studies have failed to establish the importance of self-pacing to PSI's effectiveness (Kulik, Kulik, & Smitt, 1976; Cook, 1974).

Unit Performance and Mastery Criteria

PSI courses require that students demonstrate mastery over a given study unit before they proceed to the next unit. Researchers have undertaken studies to demonstrate the value of this component as well as how course grades effect student mastery.

Unit mastery does seem to contribute to the effectiveness of PSI (Cook, 1974) and relaxation of this mastery requirement leads to a decline in the effectiveness of the PSI course (Kulik et al., 1976). Sheppard and MacDermot (1970) and Alba and Pennypacker (1972) used a performance session to judge a student's mastery over a given unit. These performance sessions usually required the student to either talk fluently on the topic for a given number of minutes or to orally answer questions at a given rate per minute. Both studies found this new criteria for mastery influenced the students' grades on examinations and resulted in more mastery of the material.

Semb (1974) investigated the functions of mastery criteria and assignment length. He found that high mastery criteria and short assignment length produced better test performance than low mastery criteria and long assignments. Semb claimed that his study validates two components of Keller's PSI.

In regard to grades, Johnston and Pennypacker (1974) have used a grading system that has emphasized the A. These PSI instructors offered other grades but did not discuss how students could earn them. In a PSI course outlined by Whitehurst (1972) students could only receive an A or an F. Semb, Hopkins, and Hursh (1973) found that student performance is highest when grade contingencies are imposed upon their behavior. Johnston and O'Neill (1973) found that the grade lable A exerted simulus control over student behavior regardless of how much work was required to earn the A. These authors found that although the A exerted influence over student behavior the B and C did not. They also found that the more precise the criteria, the greater control it will have on student behavior. They suggest that PSI instructors should set very high criteria for student performance. Whitehurst and Whitehurst (1975) also investigated the effects of contingencies that allow students to earn only an A or F compared to a full range of grades where criteria for an A is the same. They found that when students can receive only an A or F many more earn As than when a full range of grades is available. They suggest that their results indicate a contingency of A or F is preferrable over a full range of grades.

Unit Size

Keller (1968) specified that PSI courses must consist of small units of information. Semb (1974) investigated both criteria and unit length and found that short units were superior to longer units in terms of unit mastery and examination scores.

Born (1975) investigated how unit size would effect students' progress through a PSI course. Students were either tested on one unit or two units. He found that both groups did equally well on examinations and their study time was similar. According to Born, unit size does not seem to be critical compared

with other PSI variables. However, he did find that if students are tested frequently over shorter units they seem to study at an even pace and do not "cram" for examinations. O'Neill, Johnston, Walters and Rasheed (1975) reported that when units were short PSI students made steady rather than sporadic progress.

Research studies have generally supported the notion that small units of study are important for student success. When units become too long, PSI's effectiveness deteriorates (Kulik, et al. 1976).

Study Time

A concern of students and instructors alike is the amount of time it takes a student to successfully complete a PSI course. Looking at the amount of study time invested by both PSI and lecture students several investigators (Born, Davis, Whilan & Jackson, 1972; Born & Davis, 1974; Cole, Martin & Vincent, 1975) found no difference in the amount of time PSI students spend studying and preparing for their PSI course, if one also considers the amount of time lecture students spend attending lectures. These researchers have all found that PSI students exhibit consistent study behavior compared to lecture students.

Born (1975) and MawWhinney, Bostow, Laws, Blumfield, and Hopkins (1971) found that when students are tested frequently they regularize their studying. They suggest that frequent testing often associated with PSI may help students learn a regular study routine.

Who Benefits Most?

What type of student benefits most from PSI? Is PSI most helpful to those with high or low aptitude? It seems that PSI is effective regardless of student ability level (Ryan, 1974). A more definite answer to this question isn't clear.

Born, Gledhill, and Davis (1972) found that a PSI course had its greatest impact on students with average to poor academic records. They showed that students doing poorly in a lecture course improved their performance when a PSI

format was implemented and suggested that PSI procedures may produce a ceiling effect on good or superior students. In comparing the results of a PSI college physics class Austin and Gilbert (1973) found that PSI was most beneficial for the low aptitude student. They found that the high aptitude student would have done as well in a lecture course. Wood and Wylie (1975) also investigated this topic and found that the poor students profit the least rather than the most in PSI courses. Kulik, Kulik, and Milholland (1974) also found that high aptitude students did better in a PSI course in statistics and that poorer students would have done just as well in a lecture course.

So far no group seems to be hindered by PSI. Research has not located a group of students for whom PSI is less effective than conventional instruction (Kulik, et al., 1976). It seems, however, that in PSI courses good students do well and finish PSI courses quickly, average students benefit from interaction with assistants and poor students usually get an F or withdraw from the course.

Problems Implementing PSI

PSI is by no means a panacea. Incorporating a PSI class into the traditional framework of a college or university is not an easy task. Problems often crop up because many of the basic principles of PSI, like self-pacing, are difficult to accomodate in large systems. The future success of PSI will rest on the resolution of the various problems encountered by individuals and systems attempting to implement a PSI course.

Beyer (1976) listed a number of disadvantages to the PSI system outlined by Keller (1968). These include:

1. Students complain of working too hard.

2. Implementing a PSI requires a great deal of work from the course instructor.

3. Students with poor reading skills will have problems.

4. The initial start up cost, in terms of time and resources is higher than for traditionally taught courses.

5. The grading procedures employed may be controversial in some colleges and universities.

Also associated with the introduction of a PSI course are a few administrative concerns. As Cook (1974) pointed out, PSI courses ask for the reallocation of meager departmental resources for lower division courses. This may cause problems in many departments as most of the resources are typically allocated for upper division classes and senior faculty members who teach them.

Also, since lecture halls are not amenable to PSI courses, a different allocation of space is required. In order for PSI to work, space needs to be available for assistants and students to meet, discuss, take tests, record progress, etc. This will require more than the traditional space allocated for classes. Cook (1974) specified that space allocated for a PSI course should:

A) Be controlled strictly by the PSI instructor, so it can be opened for students and assistants on a flexible schedule;

B) Include furniture that is conducive to small groups, individual study, test taking and grading;

C) Include appropriate storage and filing space for keeping student records, tests and study packets;

D) Include a special area for announcements.

providing all these may present administrative problems at most colleges.

Another problem encountered at some colleges is the PSI grade distribution that contains many As. Some presume that this is the result of lower standards rather than more effective instruction. Also depending on the grading system implemented, many students may receive an Incomplete until the course work is

completed. This will cause problems in many colleges where Incompletes are given only for special circumstances. A change in an institution's grading policy may be necessary to implement some PSI courses.

Other problems encountered by those implementing PSI courses have been in, recruiting course assistants. A big problem is determining how these assistants will be compensated for their duties. Even though assistants may not be as critical as first thought, assistants will be necessary in large courses to distribute materials and to help with the record keeping and at the same time, assistants should not be exploited. In two year colleges recruiting assistants is a problem because the pool of people available for such positions is extremely limited.

Due to these administrative problems many instructors implementing a PSI course have sacrificed components of PSI. Keller (1977) has cautioned that too much accomodation of PSI will render it ineffective, thus not providing the needed alternative. Research endeavors, previously reviewed, have assisted in clarifying the absolute essentials of PSI. Perhaps what is needed is a rethinking of current administrative concerns so PSI courses can be incorporated into colleges without losing the PSI components that make it effective in terms of student performance and personalization.

Future Research Needs

If PSI is going to continue to provide a viable alternative to college educators, all aspects of PSI need to be analyzed and reanalyzed until a specific replicable technology emerges. Although there has been in excess of 200 research studies conducted on PSI many questions still remain to be answered. New studies need to attend to strict experimental design so as not to repeat the mistakes made by past researchers. Below is an outline of several research questions that may provide the springboard for future work in this area.

Since PSI has often been compared to the lecture format of instructjion, some specific attention to the lecture method is warranted. It appears that the lecture method is not a specific technology. Identifying and analyzing the various components of the lecture method would assist in not only providing a more precise comparison between these two formats but also in the clarification of the valuable components of this teaching tactic. Also research efforts could investigate the effects of including one or two PSI components into a course taught by the lecture method. Would the mere specification of precise learning objectives at the beginning of lectures influence the performance of students?

In courses taught in a PSI format research efforts should be directed in the area of reporting student performance in the form of gain scores of acquisition rates. The use of review units in a PSI format may influence acquisition rates of course material. The inclusion of specific review units may also help students incorporate individual learning objectives into a larger, more comprehensive perspective.

If assistants will continue to be used in PSI courses the training of these assistants is a topic that needs close inspection. The role of the assistants needs to be clarified and then specific techniques for effectively training assistants should be delineated. Can assistants be effectively used in non-college settings? Would the use of assistants in elementary or secondary schools present special problems?

In regard to instructors, are some instructors better suited to the PSI format than others? Are there fundamental prerequisites for instructors before they attempt to teach a course with the PSI format? Does teaching a course using PSI allow instructors to be more effective or less productive in their other responsibilities (research and public service)?

Evidence suggests that PSI isolates a minority of students whose prerequisites for the course are weak (Cook, 1974). If this is the case, are there specific prerequisites students need to be successful in a class taught using PSI? Are prerequisites unique to the subject material or to the structure of the course?

Another unanswered question concerns the amount of material in each study unit. How much material can be included in study units? The study unit length described in past reports were not adequately defined.

Semb and McKnight (1977) suggested that research is needed regarding how many PSI courses a student could take at one time? This may lead to questions about whether a PSI format is more effective for full or part-time students. Also what happend when entire schools adopt PSI? Will students continue to make progress or is there a Hawthorne effect operating for students taking a PSI course when they typically take lecture courses?

The cost of running a PSI course needs to be fully analyzed. As funding for colleges becomes scarce, few would be willing to fund creative approaches to education. Before departments commit precious funds an analysis of the costs involved should be presented. Does it cost more or less to operate a PSI course rather than a lecture cost?

Another set of research questions deals with teaching students self-management skills in a PSI course? Does teaching students in PSI lead to more self-directed work or less? Do students become dependent? Do they learn study skills that are generalized to other courses? Are there components of PSI that hamper or facilitate the acquisition of self-management skills?

The strength of PSI as an instructional alternative has been its reliance on demonstrating its value in an empirical manner. New research efforts are

continually needed so this technology can develop and continue to meet the needs of students who live in increasingly complex and changing societies.

Conclusion

One of Keller's recent reviews of Instruction technology and higher education was published in 1978 in The Behavior Analyst. After a review of current literature Keller concluded:

> "Our educational leaders, with rare exceptions, are still concerned with other matters than the technology of teaching. The survival of the institution (colleges) is not seen to depend upon the way in which it carries out its basic function, that of educating students. A college president or two, a few enlightened deans, and a handful of disillusioned or danger-loving teachers may have been affected, but the 'instructional revolution,' if there be one, is still far from bringing about reform in higher education." (Keller, 1978, p. 52)

Keller continued his review by saying that in this age when we know so much about education and improving instruction, it is alarming that we are not putting more of our knowledge into practice.

One technology that we know about is PSI. PSI is the most tested teaching tactic employed in higher education. From the many studies conducted on PSI it is safe to assume that:

A) PSI instruction leads to better student performance on final examination;

B) PSI students retain more material than lecture students as measured by follow-up examination;

C) PSI students rate the course and instructor higher than lecture students;

D) PSI students do not study longer to succeed in a PSI course, yet they study at an even pace;

E) The critical components of PSI seem to be small units of work, immediate and specific feedback given students at every step and the requirement of student mastery before the student progresses to new material.

The PSI format first outlined by Keller (1968) may not be as critical as first thought. Assistants' interaction with students does not appear to be a significant component and the role of the assistant needs to be further analyzed or deleted from the model. Self-pacing can be replaced with instructor-pacing at no cost in student proficiency at the end of the course. The self-pacing feature of PSI although not critical, may still be beneficial to particular students or at particular institutions. Further analysis of this component is also needed. Also, reliance on solely written material does not seem to be essential to the success of a PSI course. Including several forms of easily accessable media will not lessen the effectiveness of a PSI course. The absence of lectures does not seem to be a critical factor. Several instructors have successfully incorporated lectures into the PSI format. So one may conclude that the three aforementioned components:

A) Small units of work

B) Immediate, specific feedback, and

C) Mastery requirement

are the only three critical components of a PSI course. Without these the course is not a PSI course.

It appears that college instructors could improve their instruction by adopting PSI as their major teaching tactic. After a careful review of the literature it seems like the only reasonable alternative to traditional, albeit ineffective, instructional tactics. Keller (1978) was, however, pessimistic about the widespread use of PSI even after ten years of researching the procedure.

> " . . .I'm sure, that any change in teaching which threatened the 50-minute classroom hour, the calender quarter or semester; the historic role of the professor as a public speaker, and explainer, a debater, or a showman; the classic distribution of grades in college courses; the standard practices of registration, record keeping, or ceremonial congregation; the physical structure of the school room; or the relationships between student and teacher and the teacher and the administrator . . . can be expected to raise a hue and a cry, not because they threaten the quality of education, but the maintenance of the complicated system that provides it." (p. 53)

Educators whose belief in a technology is based more upon empirically gathered data rather than faith need to continue to provide the catalyst to help colleges and universities make the necessary changes so students can receive more effective and efficient instruction. PSI provides colleges with one technology to help bring about these changes. Like any technology it continues to grow and develop. The growth of this technology and other instructional technologies is dependent not only upon researchers and institutions that are willing to grow to meet new demands and this becomes responsive to the people they serve.

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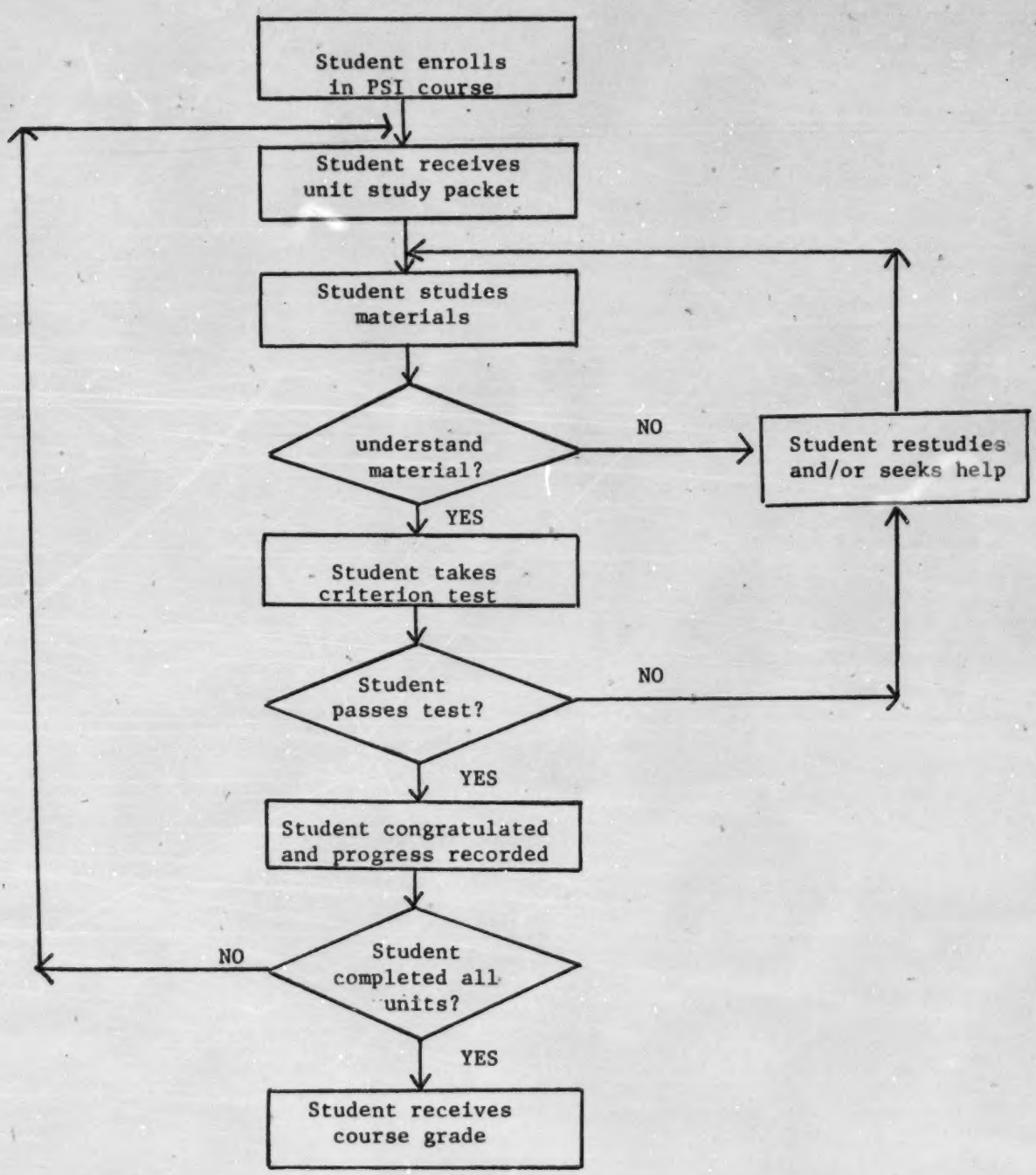

Figure 1

Flow Chart for a PSI Course